SENSOR FUZED WEAPON TAILOR MADE FOR TODAY'S AIR FORCE

Maintaining Design Currency into Production

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It is not unusual in today's world of rapidly changing technology and 6- to 10-year acquisition cycles for a weapon system to be somewhat "dated" by the time approval for production is sought. The acquisition team responsible for the Air Force's Sensor Fuzed Weapon (SFW), the first "smart" antiarmor munition to enter production, developed and executed a plan for technology insertion that can be used as a model for other programs in similar circumstances. The payoff for their efforts is lower costs, improved producibility and higher reliability while maintaining weapon lethality and effectiveness.

Program Objective

The objective of the SFW program is to provide a conventional force multiplier capable of achieving multiple kills per pass against armor and other mobile targets. The advance of sensor technology, coupled with improved standoff warhead kill mechanisms, gives significant improvement in the number of kills per weapon expended under battlefield conditions. Such improvement can be translated directly to a reduced sortie requirement, fewer dedicated aircraft needed for the antiarmor mission, and more flexibility for the area commander. In effect, SFW is a tailor-made weapon for the smaller, more flexible Air Force needed today and into the 21st Century. As a result, Air Force planners identified SFW as an essential piece of the Office of the Secretary of Defense (OSD) antiarmor strategy outlined in the "Bottom Up Review."

System Description

Each SFW (CBU-97/B) is a 1000-pound class, unpowered, unguided, free-fall, wide-area munition, stored and transported as an all-up-round in a previously fielded container. Each weapon consists of a single SUU-66/B Tactical Munitions Dispenser (TMD), 10 BLU-108/B sub-munitions, and 40 explosively formed "smart" projectiles.

The SFW employs a "wooden round" concept that requires no scheduled maintenance of any kind. The only actions required are cosmetic external actions such as paint touch-up, decal application and lanyard changeout. Internal access to the weapon/embedded software by the support community is never envisioned. In essence, the weapon is placed in storage and loaded on an aircraft when needed. As a result, the design complexity of SFW is transparent to the using command and the

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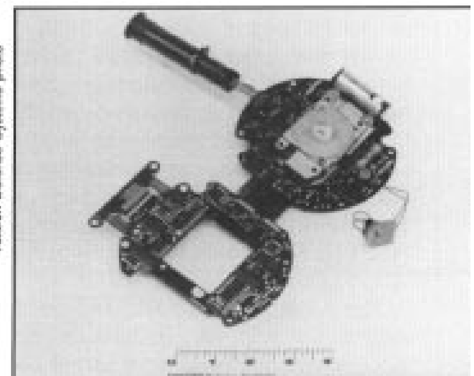

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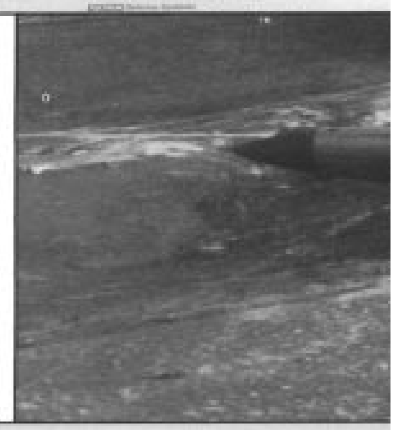

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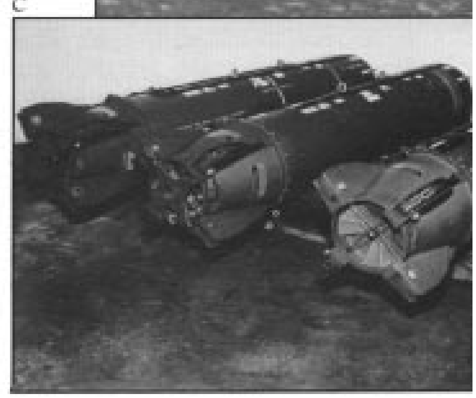

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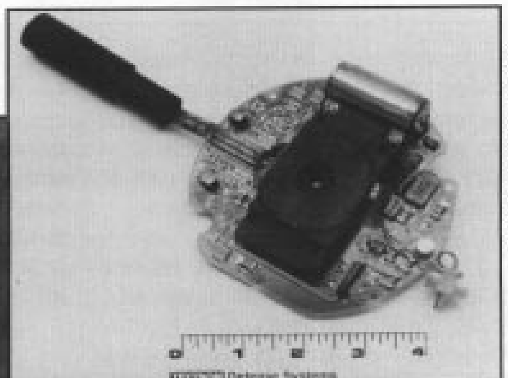
support infrastructure. Moreover, only previously fielded munitions loading equipment is required in support of storage, handling and loadcrew operations. The SFW is compatible with most U.S. Air Force, U.S. Navy/U.S. Marine Corps, and North Atlantic Treaty Organization aircraft, providing a single pass, direct-strike capability against tanks, armored personnel carriers, self-propelled artillery and trucks. For typical tactical sorties, a combat load consists of four to six CBU-97/Bs. Further, the SFW can be delivered at low or high altitudes throughout all speed regimes.



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Development History

The SFW evolved from two previously demonstrated system concepts. While the projectile (warhead) came from the Extended Range Antiarmor Munition program, the delivery vehicle, the TMD, came from the Army's Assault Breaker program. The Air Force conducted risk reduction efforts on the newly formed SFW program during the early 1980s, culminating in the successful firing of four warheads from a single submunition (BLU-108/B), hitting four separate targets in September 1985. The Secretary of the Air Force authorized Full Scale Development (FSD; now Engineering and Manufacturing Development) in November 1985, with an increase in inventory planning quantities. Due to technical problems and resulting test failures in the 1988-1989 time frame, the Air Force restructured and re-baselined the program in April 1990. From that point on, the SFW achieved a highly successful technical performance. Specifically, the SFW's performance resulted in a long string of unbroken successes: 30 of 30 successive Developmental Test and Evaluation flights; 29 of 30 Initial Operational Test and Evaluation flights (one "no test" unrelated to SFW); and three of three Production Qualification Tests representing the first inventory units.

In March, 1992, the SFW completed a major Defense Acquisition Board (DAB) Program Review. The Board subsequently gave the SFW authorization to enter into Low Rate Initial Production (LRIP). Since the initial contract award in March 1992,

A. Airborne sensor electronics — PEP 1 simplified design.
B. Airborne sensor electronics — LRIP baseline design.
C. Commonality of Sensor Fuzed Weapon (SFW) with two other inventory weapons. From left to right: 1) Gator Air Delivered Mine; 2) Combined Effects Munition; and 3) Sensor Fuzed Weapon.
D. F-16 with four Sensor Fuzed Weapons (SFW) (CBU-97) loaded.
E. Sensor Fuzed Weapon (SFW) in standard combat configuration on the F-16 aircraft.

the Air Force awarded LRIP 2 and LRIP 3. Program planning calls for one additional LRIP contract in Fiscal Year 1995, and five Full Rate Production (FRP) buys beginning in Fiscal Year 1996. A Milestone III decision for SFW to enter FRP will be made by the DAB in December 1995.

The currently planned procurement objective for SFW is 5,000 munitions. A version of the Navy-led Joint Standoff Weapon (JSOW) will employ the identical BLU-108 submunition. The JSOW carrier vehicle employs only six BLU-108 submunitions instead of the 10 carried by SFW. Thus, the planning objective of 5,000 JSOW/BLU-108 munitions will add another 3,000 SFW-equivalent munitions to the inventory.

Producibility, Cost and Design Currency

In each of the 60 successful flight tests, the robustness of the SFW design proved itself by significantly exceeding the operational user's performance requirement. As the program successfully completed FSD, the Air Force recognized that opportunities existed to drive down SFW unit production cost through the insertion of improved technology. Given the fact that over 10 years had elapsed on some of the SFW subsystem designs, the Air Force deemed technology improvements in both the design and manufacturing processes essential.

Production Transition Program

In 1989-1990, the Air Force conceived and initiated a key piece of the SFW FSD program restructure — the Production Transition Program (PTP). Specifically, the Air Force initiated the program as a risk-and-cost-reduction effort to enhance the contractor's SFW production capability, and included the following areas: (1) development of high payoff producibility enhancements; (2) development of tooling and inspection gages; (3) development of environmental stress screening levels and procedures; and (4) development and optimization of production processes. Moreover, PTP changes had to be transparent to the user and the support infrastructure in order to maintain the "wooden round" maintenance concept.

FIGURE 1. FSD Baseline vs. PTP (LRIP) Design Key Comparisons

		Baseline	PTP
1.	Projectile	Hand-insertion	100% automatic component insertion
		Assembly labor: 6.5 hours	Assembly labor: 4.0 hours
2.	Submunition Electronics	Expensive custom hybrids and old generation microprocessor	More cost effective piece parts
		Altimeter board — all inserted stand-up components	Altimeter board — discrete analog components in a through-hole design for automatic insertion
		Assembly labor: 12 hours	Assembly labor: 6.4 hours

The program consisted of two phases with decision point milestones. Phase 1 was a study phase to identify preliminary design and process candidates. In effect, the Air Force characterized and ranked production transition risk; developed producible, testable designs; and scoped high-rate production processes. As might be expected, the Air Force identified the major cost drivers for the SFW in order to select those projects which would give the biggest payback.

It is important to note that the SFW cost drivers are not individually high-cost items. The Air Force designed the munition with 10 submunitions (BLU-108/B), and 40 individual projectiles per weapon. Therefore, a single item that appears low priced may be a major cost driver when multiplied 40 times. This multiplier effect associated with the SFW design, would also be the basis for all subsequent producibility efforts.

Phase 2 of the program actually involved the development, demonstration and qualification of those previously identified engineering and manufacturing changes. Project areas included the following: projectile electronics, submunition nose electronics (includes submunition altimeter), Infrared (IR) Sensor Qualification, submunition launcher housing, modular orientation and stabilization unit, and the *submunition rocket* motor (Figure 1).

The completion of PTP was a significant milestone for the SFW program. The program was a $30 million investment that was completed on schedule, at target cost, and achieved all of its stated goals. Actual cost savings achieved by the program exceed $128 million (BY 91$, 5000 units). At PTP inception, SFW procurement quantities were over three times what they are today. Cost savings against that early baseline quantity would have exceeded $340 million.

Significantly, PTP achieved these cost savings, reduced production risk, and simultaneously maintained SFW's vaunted system performance. The Air Force conducted a five-flight test series (based on the PTP configuration) early in 1993, and the results exceeded the operational user's performance requirement by 100 percent. As a result of these successes, the Air Force introduced PTP initiatives into the SFW baseline design two LRIP lots ahead of schedule. In essence, this earlier cut-in generated more cost savings and reduced the risk of transition to production even more.

Producibility Enhancement Program

Although OSD recognized the successes of PTP at the March 1992 DAB Program Review, they felt that even more producibility cost reductions could be attained for a modest investment. As a result, the March 1992 Acquisition Decision Memorandum (ADM) directed the Air Force to further improve the producibility of the SFW design without negatively impacting the demonstrated performance:

> Concurrent with LRIP, the Air Force shall immediately initiate an accelerated Producibility Enhancement Program (PEP). In the PEP, the Department will make every effort to significantly improve the SFW design for enhanced producibility, increased reliability and reduced cost (ADM, March 1992).

Moreover, PEP progress was tied directly to the Milestone III production decision scheduled for December 1995.

Employing the same thought processes that went into PTP, the SFW team identified the projectile (40 per weapon) and the BLU-108/B submunition (10 per weapon) as areas that could generate a more producible design at reduced cost. As an analogy, PTP could be thought of as harvesting "low lying fruit," while PEP involves moving up to the next layer of branches. Thus, PEP changes can be characterized as slightly more complex than those completed in PTP, although both programs would be considered low to moderate risk.

Originally envisioned as a single program, PEP was eventually separated into two distinct packages due to funding constraints. The Air Force initiated Package 1 of the PEP (PEP 1) in September 1992 as a series of projects focused on the SFW projectile. The projectile is significant because it represents 30 percent of the recurring cost of the entire weapon. Specific PEP 1 initiatives include the following areas: the integration of Application Specific Integrated Circuit (ASIC) technology into the projectile electronics; reducing the complexity of the projectile Safe and Arm device; and manufacturing simplification of the IR Sensor. The Air Force projects a dramatic 42-percent reduction in total parts for this effort, resulting in a simplified design and significantly lower weapon unit costs (Figure 2). Moreover, the Air Force will incorporate PEP 1 into the SFW production baseline in LRIP 4 (Fiscal Year 1995), and conduct a performance demonstration of five flight tests scheduled for mid-1995.

The completion of PTP was a significant milestone for the SFW program. The program was a $30 million investment that was completed on schedule, at target cost, and achieved all of its stated goals.

Due to continuing funding constraints, the Air Force did not initiate Package 2 of the PEP (PEP 2) until a year later than envisioned (October 1993), forcing a restructure of the effort. Despite these difficulties, the goals of PEP 2 did not change. Accordingly, PEP 2 continued to focus on improving the design of the submunition nose electronics, a major weapon cost driver. Specific PEP 2 initiatives include the following areas: integrating the submunition altimeter and sequencer into a single processor through the introduction of ASIC technology; decreasing the total subsystem component count; and simplifying the fabrication and assembly of the submunition electronics. Although it is relatively early in the PEP 2 program, conservative estimates for the submunition nose electronics project a total parts reduction of over 40 percent (Figure 3). Flight testing of PEP 2 is scheduled for late 1996 with subsequent incorporation into the second FRP lot.

Current cost savings estimates for PEP exceed $108 million based on conditions existing during the DAB Program Review (BY 91$, 10,000 units). Then-year savings for PEP represent some $133 million. The Air Force obtained these projected PEP cost savings from a parts-in/parts-out analysis based on actual LRIP com-

FIGURE 2. LRIP Baseline vs. PEP 1 Key Comparison

Baseline	PEP 1
222 Total parts	128 Total parts (42% reduction)
Double rigi-flex board	Single, conventional board
Discrete Analog Components	Highly integrated ASIC
Through-hole technology	Surface mount technology
Assembly labor: 4 hours	Assembly labor: 2.5 hours

FIGURE 3. LRIP Baseline vs. PEP 2 Key Comparison

Baseline	PEP 2
209 Total parts	122 Total parts (42% reduction)
Separate processor for altimeter and sequencer	Single, shared processor
Discrete Analog components	Highly integrated ASIC
Custom expensive RF power source	Off-the-shelf, cost effective RF power source

ponent costs. Thus, PEP is achieving the goals of enhanced producibility, reduced cost and improved reliability for the SFW design set by OSD.

Summary

The SFW is a force multiplier representing a new generation of "smart" weapons. Moreover, military planners at the highest levels of DoD and Air Force identified it as an essential piece of OSD antiarmor strategy outlined in the "Bottom Up Review." Like many other major acquisition programs, SFW experienced an extensive (in excess of 10 years) development cycle that produced a highly effective but somewhat "dated" design as the weapon transitions to production. In effect, Air Force challenged the SFW team to update the weapon design by incorporating a series of producibility enhancements, while simultaneously preserving the demonstrated operational performance.

The producibility improvements represented by PTP and PEP have already substantially driven down, and will continue to drive down, production costs for SFW. These lower production costs equate directly to affordability for the operational user at a time when the budget continues to decline.

Reference

Office of the Under Secretary of Defense for Acquisition, Acquisition Decision Memorandum, "The Sensor Fuzed Weapon Program," 26 March 1992.

MANAGING EDITOR RETIRES — DSMC WELCOMES REPLACEMENT

The staff and faculty of the Defense Systems Management College recently said a reluctant good-bye to Ms. Esther M. Farria, managing editor, *Program Manager* — the College's flagship periodical. Esther retired effective 15 October 1994 after a splendid career with the College — nine years as associate editor and one year as managing editor. She plans to divide her time between her homes in Manassas, Va., and Myrtle Beach, S.C.

Effective 3 October 1994, we welcomed Ms. Collie J. Johnson as the new managing editor. Collie brings many years of writing and editing experience to our magazine. Her career highlights include assignment as technical writer-editor of six "Army Study Highlights" winners, U.S. Army Engineer Strategic Studies Center; writer-editor for the Tailhook Task Force, Department of Defense Inspector General; and writer-editor for production of the Pentagon "Early Bird," Armed Forces Information Service.